

Evaluating the Impact of Chinese FDI in the Energy Sector on Green GDP Growth: A Spatial Econometric Analysis of MENA Countries

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Abstract: This study analyzes the impact of Chinese foreign direct investment (FDI) in the energy sector on the green GDP (GGDP) growth of seven Middle East and North Africa (MENA) countries based on data from 2009 to 2019. Using panel regression analysis, the study focuses on the effects of FDI, economic development level, population size, energy consumption structure, environmental regulation intensity, government fiscal expenditure, and the KOF Economic Globalization Index on GGDP growth. By comparing fixed-effects and random-effects models and applying the Hausman test to select the most appropriate model, the research indicates that the random-effects model is the most suitable. The results show that FDI, economic development level, and population size have significant positive effects on GGDP, while shifts in energy consumption structure also promote sustainable economic growth. In contrast, environmental regulation intensity and the globalization index have no significant impact on GGDP, suggesting that GGDP growth in MENA countries relies more on internal economic policies and the efficiency of resource allocation.

Keywords: Green GDP, Foreign direct investment, MENA countries, Energy sector, Random-effects model.

1. Introduction

The Middle East and North Africa (MENA) region is renowned for its abundant energy resources and strategic geopolitical importance. In recent years, China's foreign direct investment (FDI) has played a critical role in reshaping the energy landscape of MENA countries. Energy serves as a key driver of both domestic and global economic growth, making it essential to understand the impact of Chinese FDI on the green GDP growth in these countries. GGDP is a vital indicator for evaluating sustainable economic development, as it accounts for the environmental costs associated with economic activities.

This paper aims to assess the influence of several key factors in the energy sector—such as energy consumption, environmental regulation, government spending, financial development, and globalization—on GGDP growth. Using data from seven MENA countries—Algeria, Egypt, Oman, Qatar, Saudi Arabia, the United Arab Emirates, and Morocco—spanning from 2009 to 2019, the study employs a panel regression model to explore the economic interdependencies among these nations.

The significance of this research lies in its analysis of the impact of Chinese FDI on the energy sector in MENA countries, providing policy insights on how foreign investment can be optimized to support sustainable economic growth. The findings will contribute to the academic discourse on regional sustainable development and the role of FDI in driving energy transitions.

2. Literature Review

As China's global economic influence continues to expand, particularly under the Belt and Road Initiative (BRI), its

foreign direct investment (FDI) in the energy sector has had profound implications for the economic and environmental development of Middle East and North Africa (MENA) countries. In recent years, there has been an increasing focus on how Chinese FDI impacts green GDP (GGDP) growth. However, certain gaps remain in fully understanding these dynamics, particularly in terms of spatial spillover effects and sustainability. This literature review examines several key studies to understand how Chinese FDI affects economic growth, environmental sustainability, and spatial interdependencies in the MENA region.

Dong Huimei et al. provided an important contribution to the understanding of investment risks faced by Chinese energy companies in Algeria [1]. Through a "PCA-EM" model, they measured the dynamic evolution of investment risks from 2002 to 2018. Their findings highlighted that political and economic risks were the most significant factors influencing investment decisions. This research sets a foundational framework for examining how investment risks evolve in other MENA countries and informs this study's approach to assessing Chinese FDI's impact on economic and environmental factors, including GGDP growth.

Complementing this, Hao Yubiao et al. explored the historical evolution of China's outward investment management policies, which have moved from strict regulatory approval processes to the more flexible filing system currently in place [2]. Their study emphasized China's shift in investment strategies from compensating for domestic market resource shortages to fostering global economic co-development. This change in investment philosophy provides critical insights into China's strategic expansion in the MENA region's energy sector, particularly regarding how the nation's policy adaptations influence the effectiveness of FDI in promoting sustainable development.

In the context of the Belt and Road Initiative, Wang Jin examined the regulatory barriers that hinder China's infrastructure investments in BRI countries, including those in the MENA region [3]. His empirical analysis revealed that stringent entry regulations significantly reduced Chinese companies' investment scale and willingness, particularly in energy and infrastructure sectors. This study offers valuable policy implications for addressing regulatory challenges and optimizing the flow of Chinese FDI in the MENA energy sector, with particular emphasis on how regulatory environments can impact GGDP growth.

From a historical and diplomatic perspective, Tang Baocai's study on the establishment of diplomatic relations between China and Egypt underscores the long-term strategic importance of Sino-MENA relations [4]. His research highlighted how strong bilateral relations have facilitated economic and cultural exchanges, further enabling cooperation in critical sectors such as energy. The historical framework provided by this study helps to contextualize China's sustained interest in fostering deeper economic ties with MENA countries through energy sector investments, contributing to GGDP growth.

In terms of environmental sustainability, Liu Li and Yang Yulu presented an important review of recent advancements in environmental resource accounting [5]. Their study highlighted the importance of improving the classification and measurement of environmental assets, which is crucial for evaluating GGDP. This research provides theoretical backing for understanding how environmental costs, driven by Chinese FDI, can be better integrated into sustainable development metrics like GGDP in the MENA region.

Further, Liu Yujin analyzed the relationship between energy consumption and green economic growth using error correction models, concluding that higher energy consumption positively influences green GDP, while environmental pollution has a negative impact [6]. This study is particularly relevant for MENA countries that are heavily dependent on fossil fuels, as it provides insights into how the energy consumption structure can be optimized to foster GGDP growth while minimizing environmental harm.

Lastly, Wang Yao developed an evaluation system for assessing green development under China's dual carbon goals [7]. Though focused on China's agricultural sector, the methodology and findings regarding the relationship between green development and GGDP provide a useful parallel for understanding similar dynamics in MENA's energy sector. This study reinforces the importance of evaluating sector-specific contributions to GGDP growth, especially in regions undergoing energy transitions like MENA.

The existing literature highlights the critical role that Chinese FDI plays in driving GGDP growth in MENA countries. The studies reviewed emphasize the importance of managing investment risks, navigating regulatory frameworks, and fostering diplomatic ties to enhance the positive impact of FDI in the energy sector. However, there remains a need for further research into the spatial spillover effects of Chinese FDI and how it contributes to green economic transitions across different MENA countries. By filling these gaps, future research can offer more comprehensive policy recommendations for optimizing the economic and environmental benefits of foreign investments in the MENA region's energy sector.

3. Empirical Research

3.1. Data and Variables

This empirical study is based on a dataset covering the years 2009 to 2019 for seven MENA countries, including Algeria, Egypt, Oman, Qatar, Saudi Arabia, the United Arab Emirates, and Morocco. The dataset provides an ideal foundation for analyzing the impact of Chinese FDI on the green GDP of these countries. Table 1 presents the dependent and explanatory variables, along with their sources.

Table 1. Variables and Sources

Variable	Sources of variables
Green GDP	The database is sourced from reference [8].
FDI	World Bank
Energy Consumption Structure	Energy Institute, World Energy Statistical Review (2023)
Environmental Regulation Intensity	IMF
Government Fiscal Expenditure	International Monetary Fund (IMF), Government Finance Statistics; Organisation for Economic Co-operation and Development (OECD), Data Extraction.
Population Size	World Bank
Financial Development Level	IMF
Economic Globalization Index	The database is sourced from reference [9-10].

3.2. Model Setup

To investigate the spatial relationships among Middle East and North Africa (MENA) countries, this study employs panel regression analysis with log-transformed data. The model is specified as follows:

$$GGDP = \alpha + \beta_1 \times FDI + \beta_2 \times \text{Energy Consumption Structure} + \beta_3 \times \text{Environmental Regulation} + \beta_4 \times \text{Government Expenditure} + \beta_5 \times \text{Population} + \beta_6 \times \text{Financial Development} + \beta_7 \times \text{Economic Globalization Index} + \epsilon \quad (1)$$

3.3. Empirical Results

The empirical research results are shown in Table 2.

Table 2. Random-Effects GLS Regression Results

Variable	Coefficient	P> z
FDI	0.0577207	0.001
Financial Development Level	1.040308	0.000
Population Size	0.9862655	0.000
Energy Consumption	1.575414	0.000
Environmental Regulation Intensity	-0.1238708	0.941
Government Fiscal Expenditure	1.333938	0.009
Economic Globalization Index	-0.0431768	0.708

This study employs a panel data model to analyze the impact of Chinese foreign direct investment (FDI) in the energy sector on the green GDP (GGDP) growth of Middle Eastern and North African (MENA) countries. Utilizing data from seven MENA countries between 2009 and 2019, the study examines the effects of FDI, economic development level, population size, energy consumption structure, environmental regulation intensity, government fiscal

expenditure, and the KOF Economic Globalization Index on GGDP growth. By comparing fixed-effects and random-effects models, and applying the Hausman test to identify the most appropriate model, the results indicate that the random-effects model is the most suitable for this dataset.

The results from the random-effects model demonstrate that FDI has a significant positive impact on GGDP growth in MENA countries. This suggests that Chinese investments in the energy sector have effectively contributed to sustainable economic growth in the region. As Chinese energy investments in these countries have increased, GGDP has shown a steady upward trend, reflecting the important role that foreign capital plays in driving energy transitions and sustainable development. Additionally, economic development level and population size have consistently been significant drivers of GGDP growth. Improved economic development not only brings higher income and productivity but also fosters investment in energy transitions and environmental protection. The increase in population size indicates rising energy demand, which in turn drives GGDP growth to some extent. MENA countries, particularly Saudi Arabia, Qatar, and the United Arab Emirates, where populations are growing rapidly, have exhibited this trend.

In terms of energy consumption, the energy consumption structure has a significant positive impact on GGDP. Countries that rely more on renewable energy, such as the United Arab Emirates and Morocco, have demonstrated higher GGDP growth rates. This finding highlights the critical role of transitioning to cleaner energy sources, with changes in energy consumption structure significantly promoting sustainable economic development.

The environmental regulation intensity did not prove to be significant, which may reflect the variation in the implementation of environmental policies across countries. In some nations, stringent environmental policies may require more time before they exert a significant positive effect on GGDP.

The positive impact of government fiscal expenditure on GGDP was significant in the random-effects model, indicating that public investment in energy infrastructure and related projects is crucial for promoting sustainable economic growth. Governmental efforts in MENA countries to support green transitions play a vital role in achieving long-term environmental sustainability.

Finally, the Economic Globalization Index did not have a significant impact on GGDP in the random-effects model, suggesting that the degree of global economic integration is not a primary driver of GGDP growth in MENA countries. While globalization facilitates the flow of international capital and technology transfer, GGDP growth in MENA countries may depend more on internal economic policies and the efficiency of resource allocation.

4. Conclusion

The findings of this study highlight the significant positive impact of Chinese FDI in the energy sector on GGDP growth in MENA countries. The random-effects model shows that Chinese energy investments have played a crucial role in fostering sustainable economic growth in the region, with GGDP exhibiting a steady upward trend. Additionally,

economic development and population growth have emerged as important drivers of GGDP, while the transition towards renewable energy sources further accelerates this growth. Despite the lack of significance in environmental regulation intensity and globalization, the study emphasizes the importance of domestic policies and resource allocation efficiency in determining GGDP growth. Overall, this study underscores the need for MENA countries to continue investing in clean energy and sustainable development initiatives to maintain long-term economic and environmental stability.

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